The role of DYNAMO observations in improving GMAO reanalysis and CERES-like estimation of surface atmosphere radiation

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Motivation

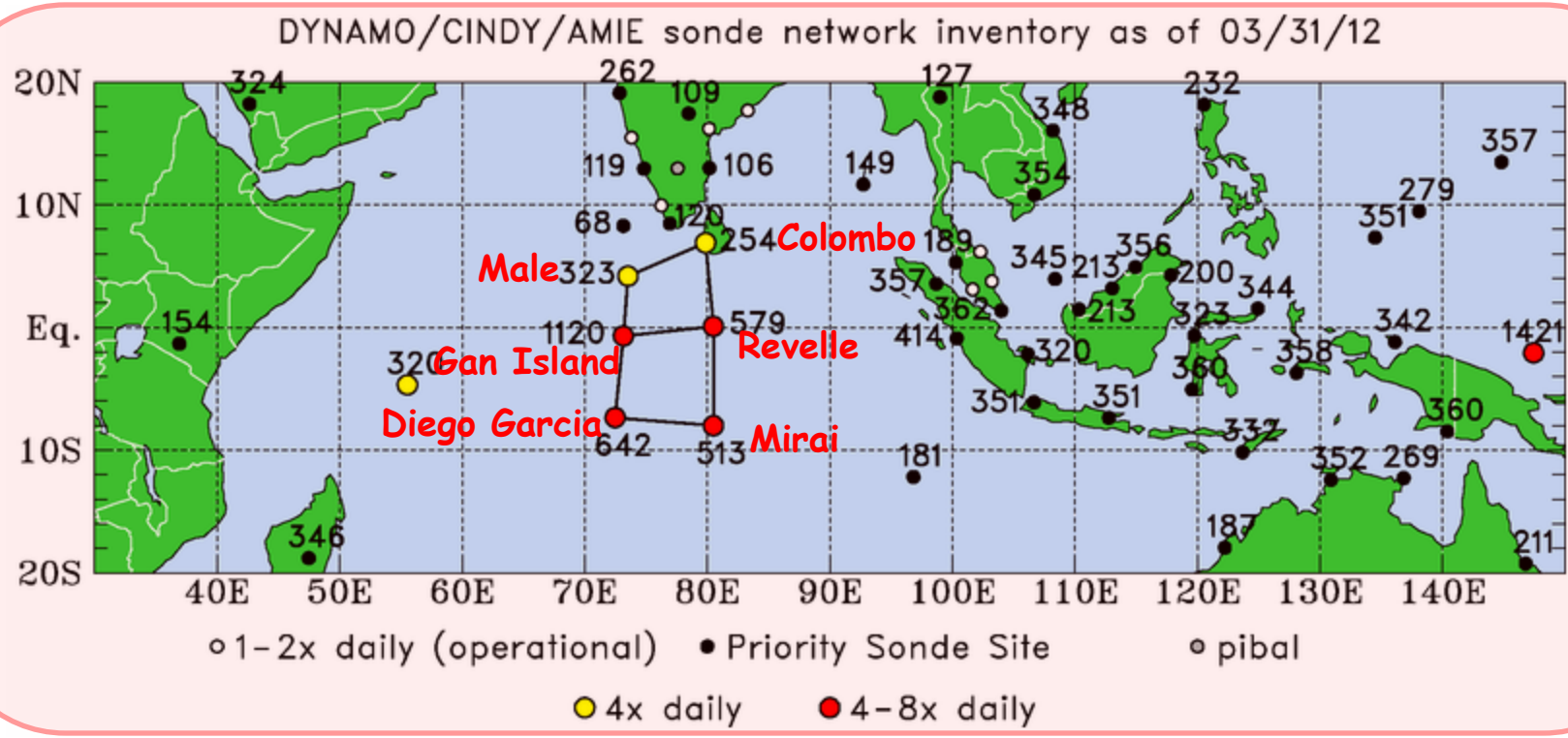
- CERES EBAF-Surface (monthly) and SYN1deg_Lite (daily):
  - have been used to study observed phenomena (e.g. MJO)
  - are based on Fu-Liou radiative transfer calculations which use GMAO reanalysis as an input, their quality is thus subject to the GMAO reanalysis data used

- GMAO reanalysis can be improved by:
  - improving GEOS-5 AGCM, e.g. model moist physics in tropics
  - improving GEOS-5 data assimilation system (DAS)
  - assimilating observations that were previously unavailable, particularly in-situ obs over vast oceans
    - e.g., DYNAMO field observations over tropical Indian Ocean

DYNAMO
(Dynamics of Madden-Julian Oscillation)

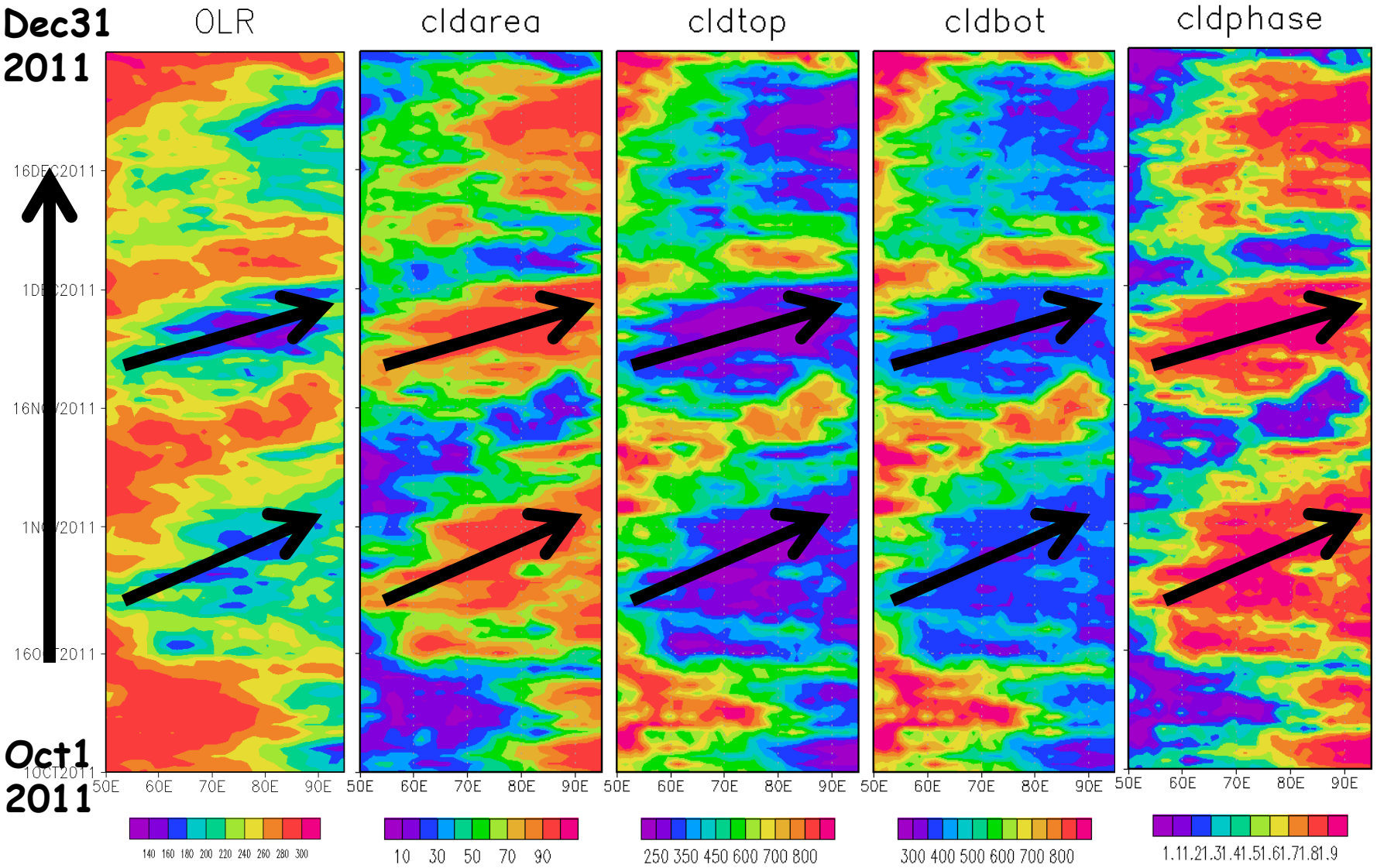
- A field campaign that took place in the Indian Ocean during October 2011 – March 2012 to collect in-situ observations, especially those for the MJO initiation processes

- Provides in-situ observations of T and Q, particularly their vertical profiles



https://www.eol.ucar.edu/system/files/DYNAMO-summary.pdf

CERES SYN1deg_Lite Ed3A
Tropical Indian Ocean (0-10N Mean)



During convective events (e.g. MJOs):
OLR↓; cloud amount↑; cloud top and bottom altitudes↑; ice dominant; τ↑

Objectives & Approaches

- Assess impact of DYNAMO observations on GMAO reanalysis

- … and subsequent effect on CERES-like surface atmosphere radiation estimation (case study)

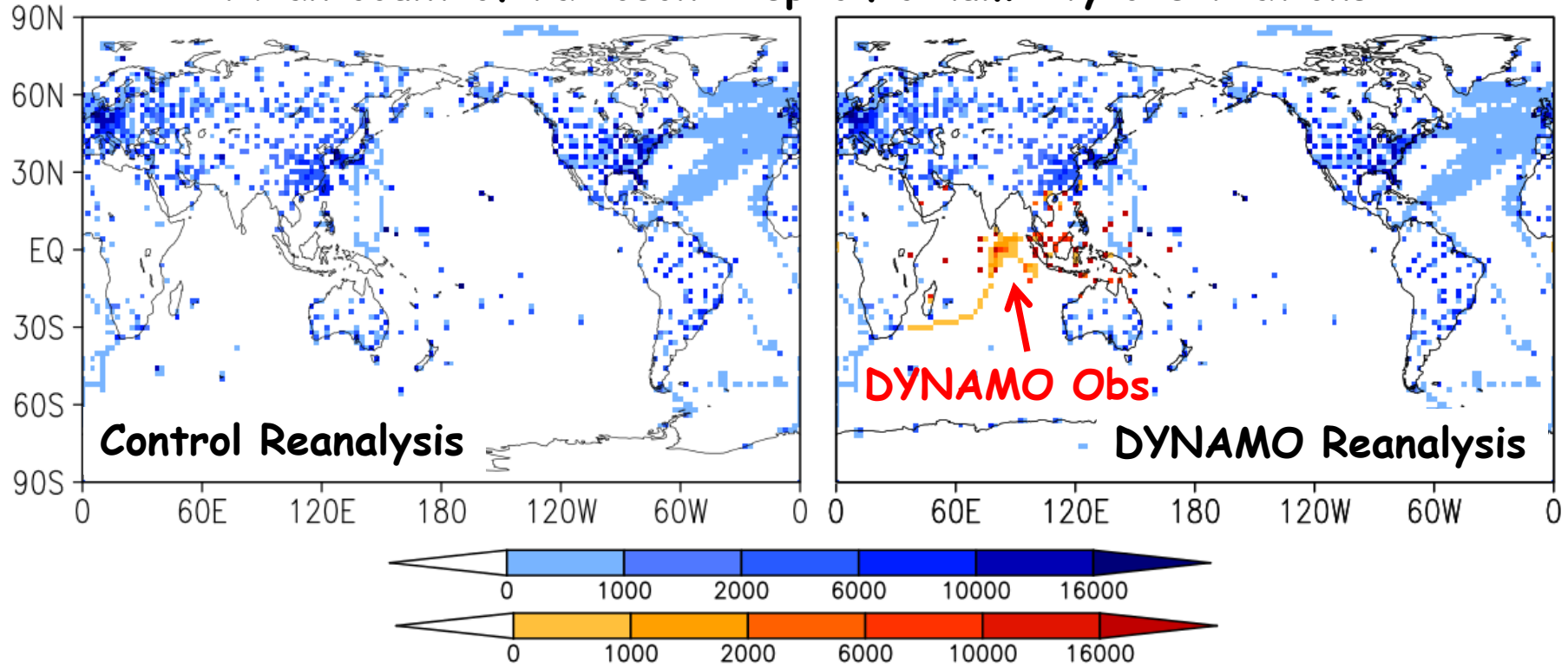
Objectives & Approaches

- Assess impact of DYNAMO observations on GMAO reanalysis
  - Produce Control reanalysis and DYNAMO reanalysis
    - respectively assimilate global observations without and with DYNAMO observations
  - MERRA2 tag; 1 degree resolution
  - DYNAMO period: 1Oct2011-31Mar2012
- … and subsequent effect on CERES-like surface atmosphere radiation estimation

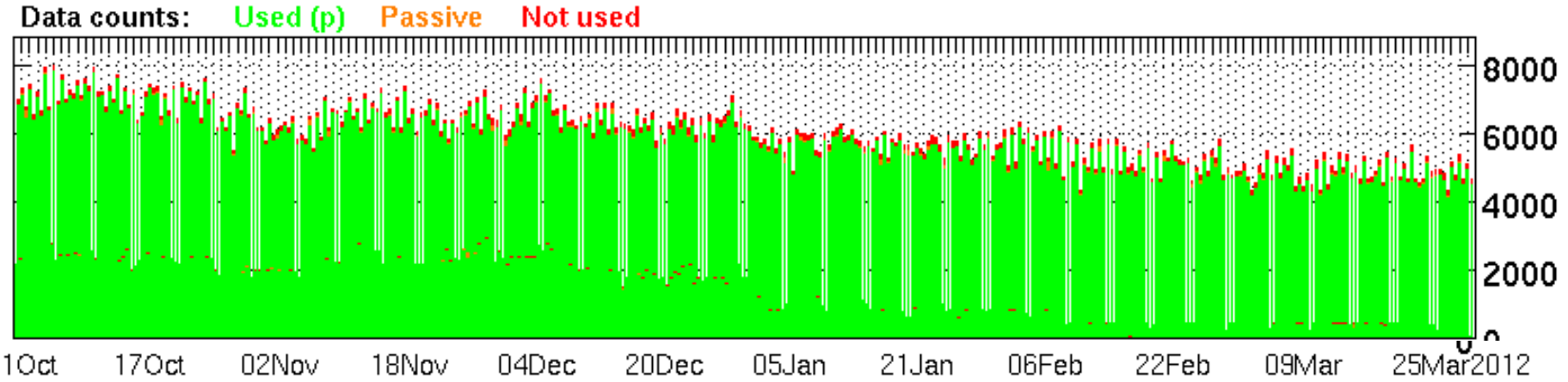
DYNAMO Obs Assimilated

- Spatially complete and quality controlled
  - L4 5mb Radiosonde at 33 sites (7 enhanced sites;4 ships; 1 dropsonde; 21 PSS)
  - Pibal GTS Resolution Winds L4 Data at 27 sites (20 PSS + 7 NPSS)
  - NPSS GTS Resolution L4 Data at 16 NPSS (6 NPSS in GMAO blacklist)
  - PSS GTS Resolution L4 Data at 24 PSS (7 PSS in GMAO blacklist)
  - Produced by Richard Johnson and Paul Ciesielski at CSU

Mean count of radiosonde specific humidity observations

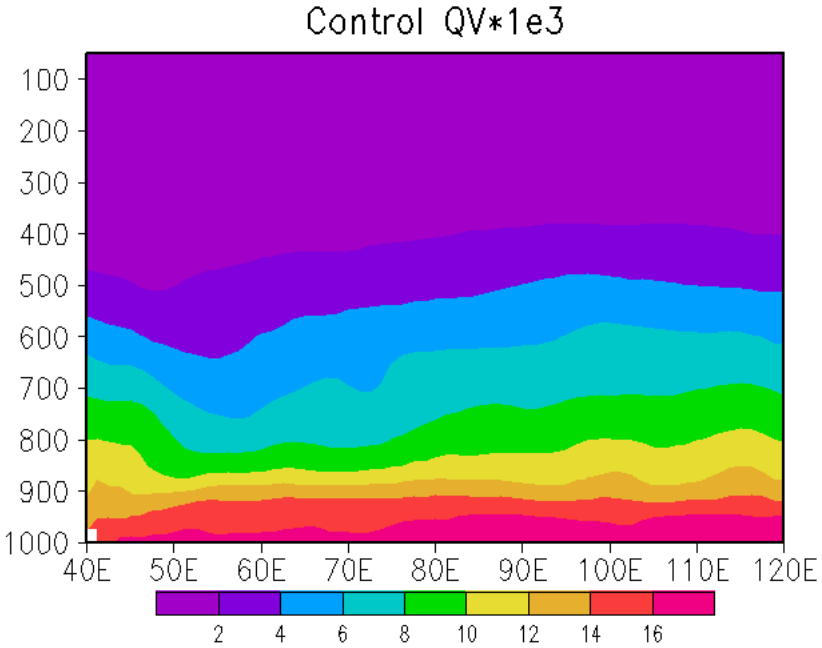


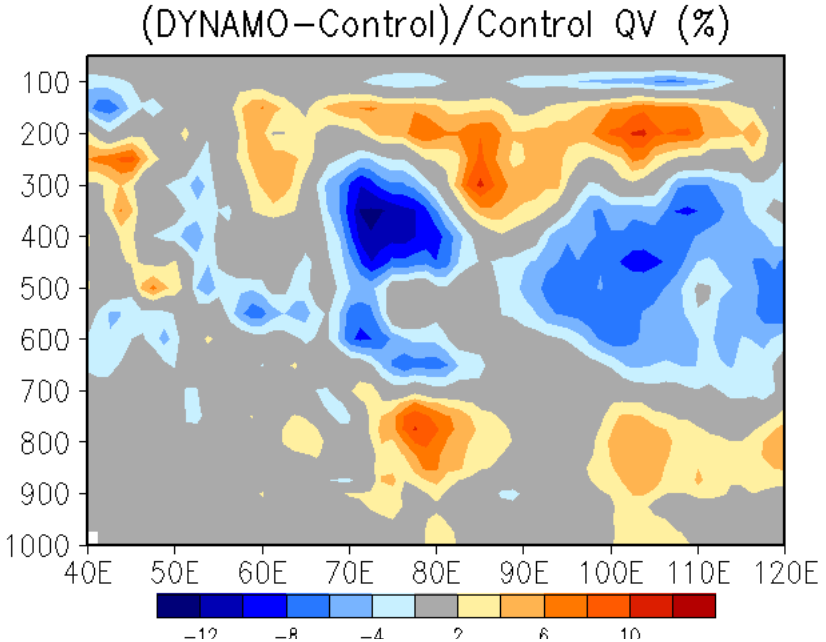
Time series of DYNAMO radiosonde specific humidity data count

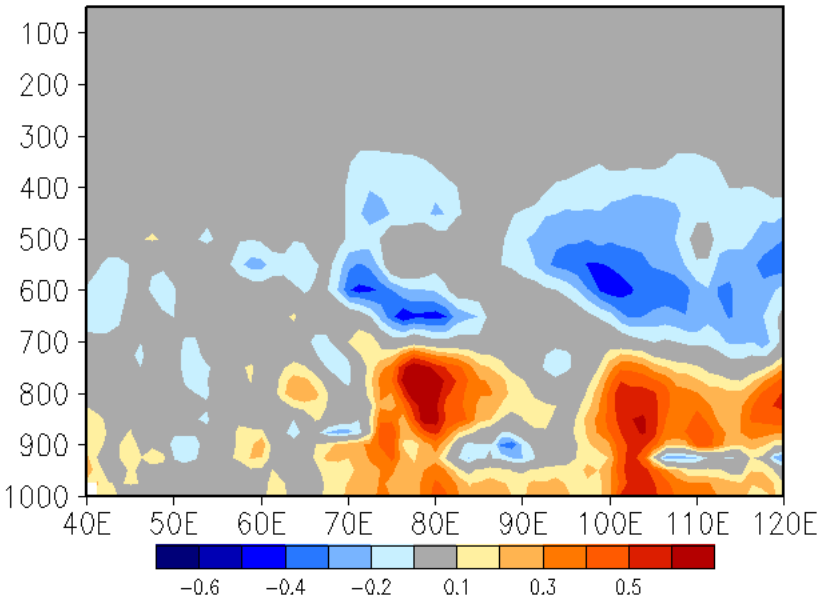


Control vs. DYNAMO: Specific Humidity (Q)

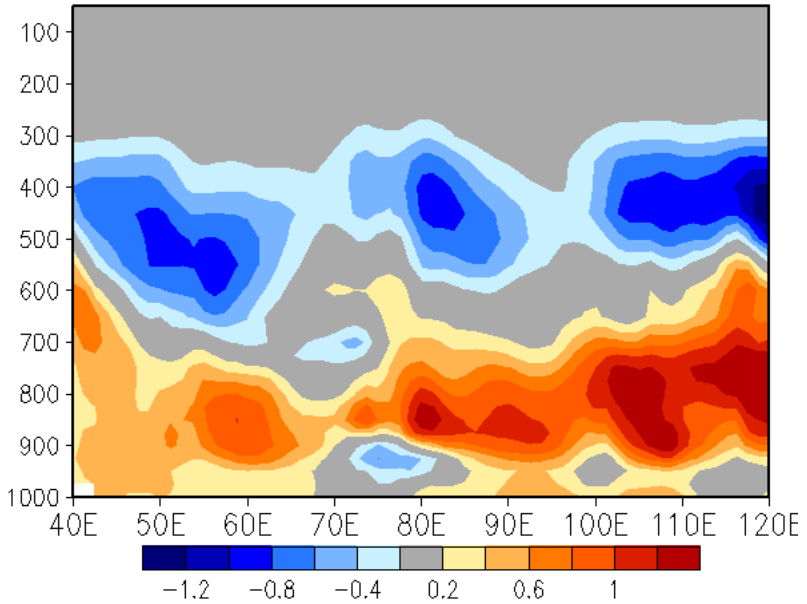
0-10N Mean; Oct2011







Q tendency due to analysis

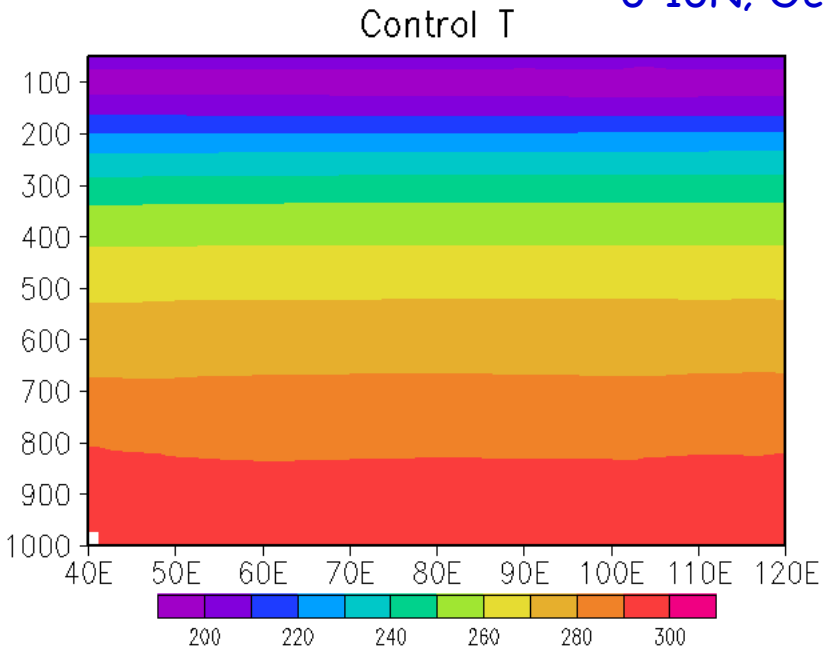


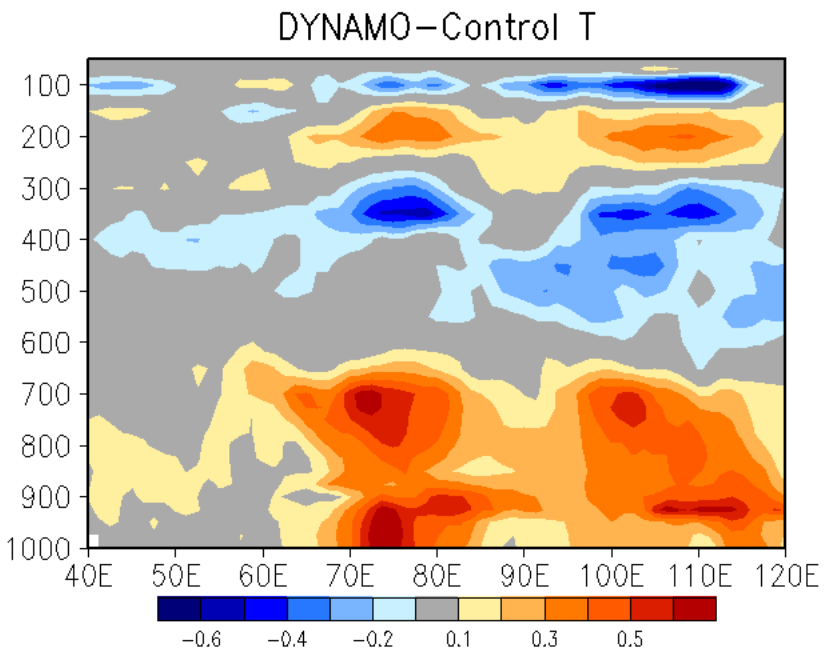
wet bias

dry bias

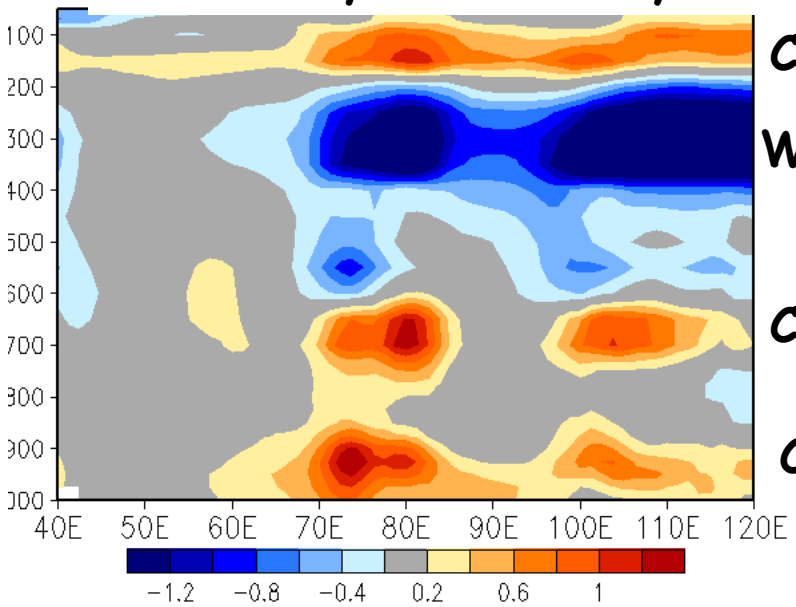
Control vs. DYNAMO: Air Temperature (T)

0-10N; Oct2011





T tendency due to analysis



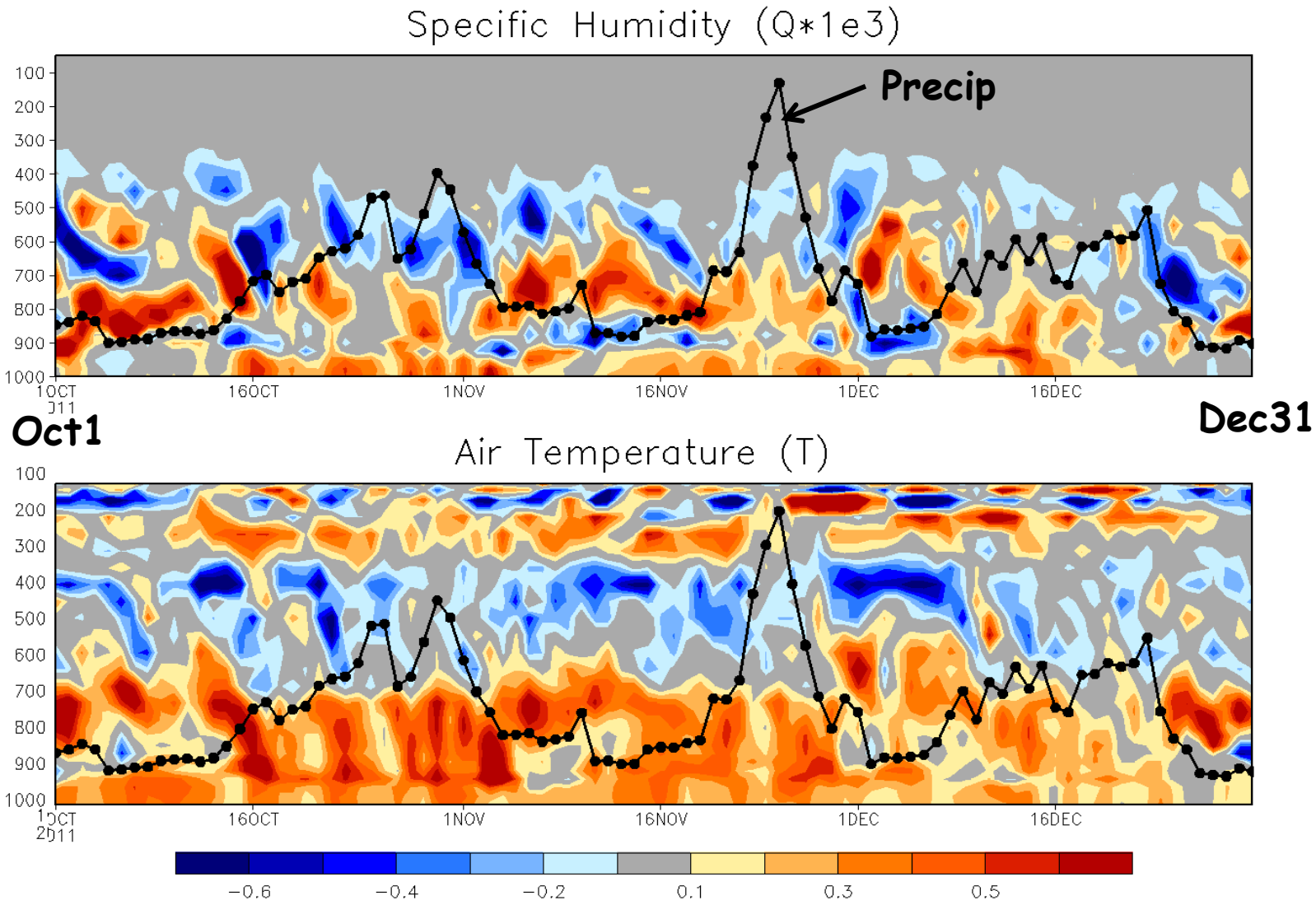
Cold bias

Warm bias

Cold bias

Cold bias

DYNAMO-Control: [60E-90E; 0-10N] mean



Q: How do the changes in GMAO reanalysis T and Q from assimilating DYNAMO obs affect the estimation of CERES-like surface atmosphere radiative fluxes?

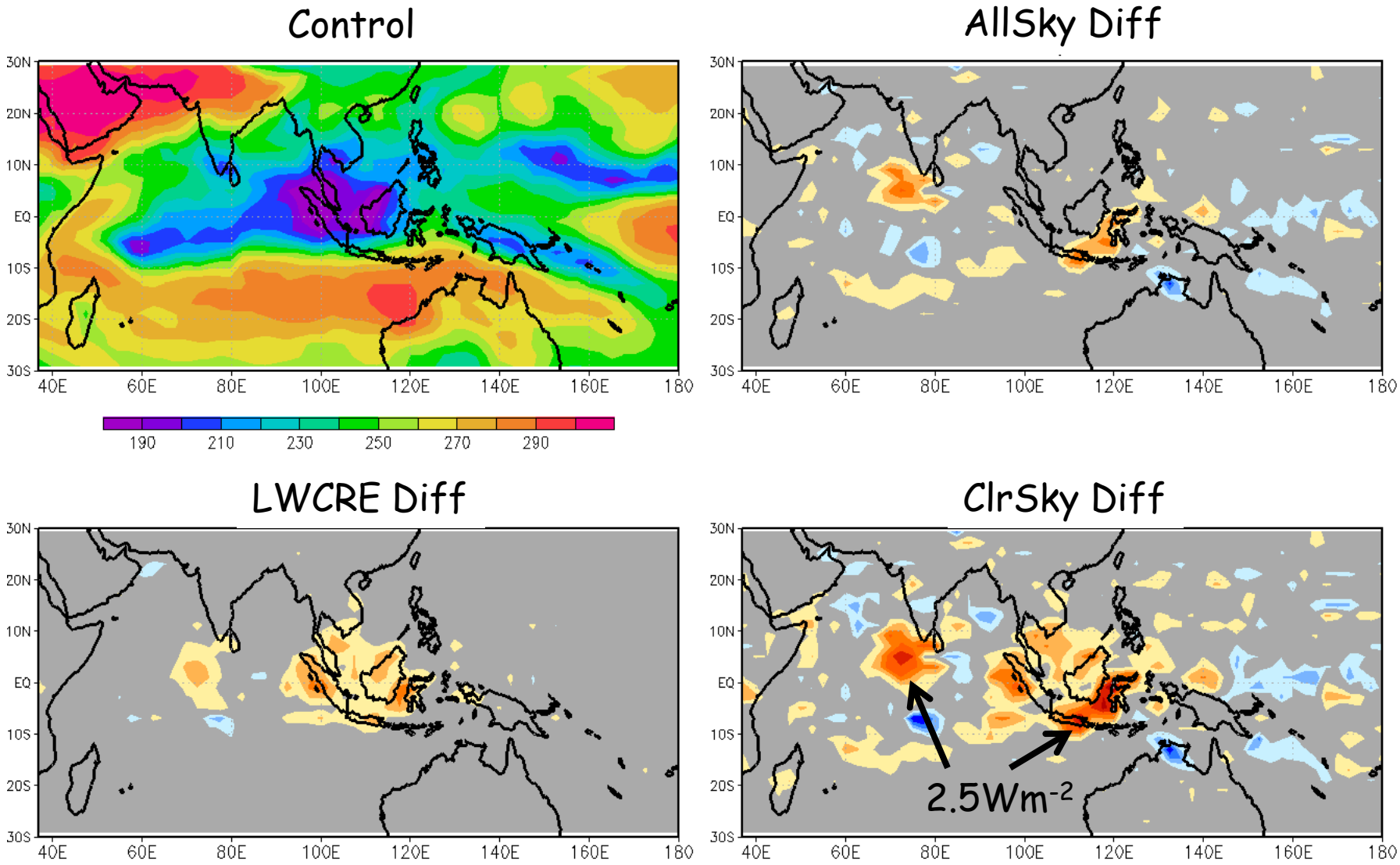
Objectives & Approaches

- Assess impact of DYNAMO observations on GMAO reanalysis

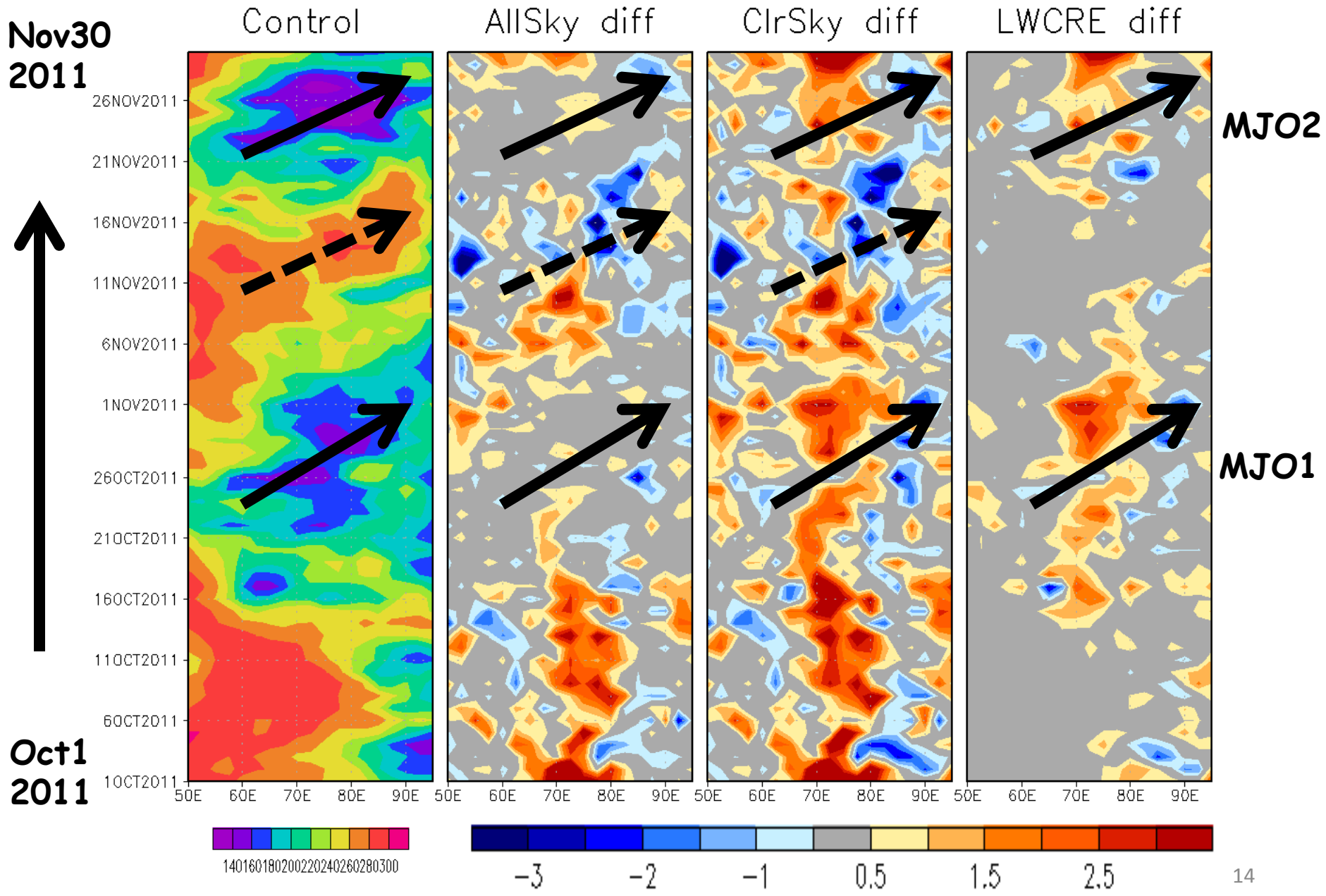
- … and subsequent effect on CERES-like surface atmosphere radiation estimation
  - Fu-Liou calculations (preliminary)
    - 1Oct-30Nov2011; daily mean
    - T & Q from GMAO reanalyses; rest from CERES SYN1deg_Lite Ed3A
      - Control T&Q
      - DYNAMO T&Q
      - Control T & DYNAMO Q
      - Control Q & DYNAMO T

OLR: Oct2011

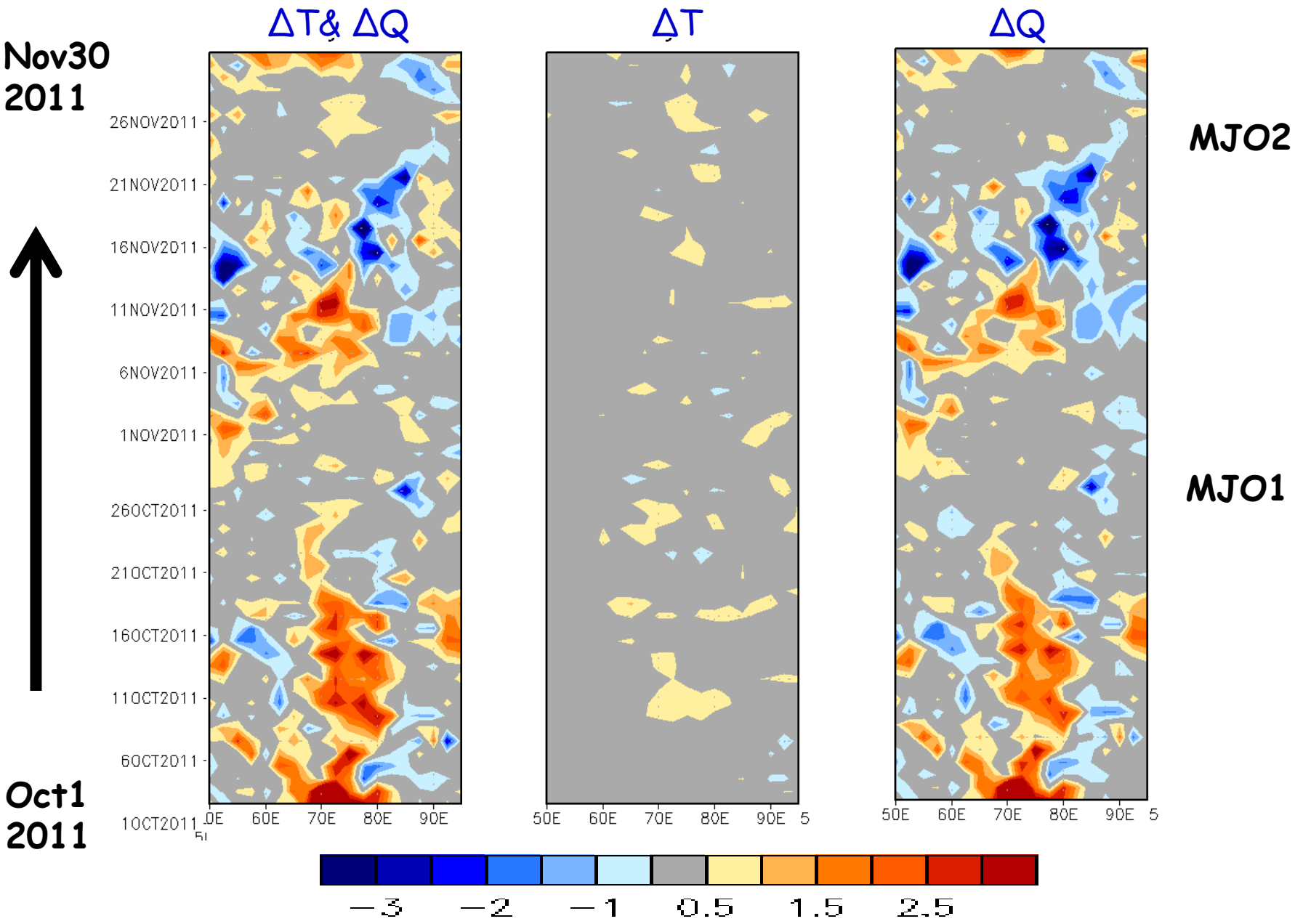
FuLiou_DYNAMO vs. FuLiou_Control



OLR: 0-10N Mean



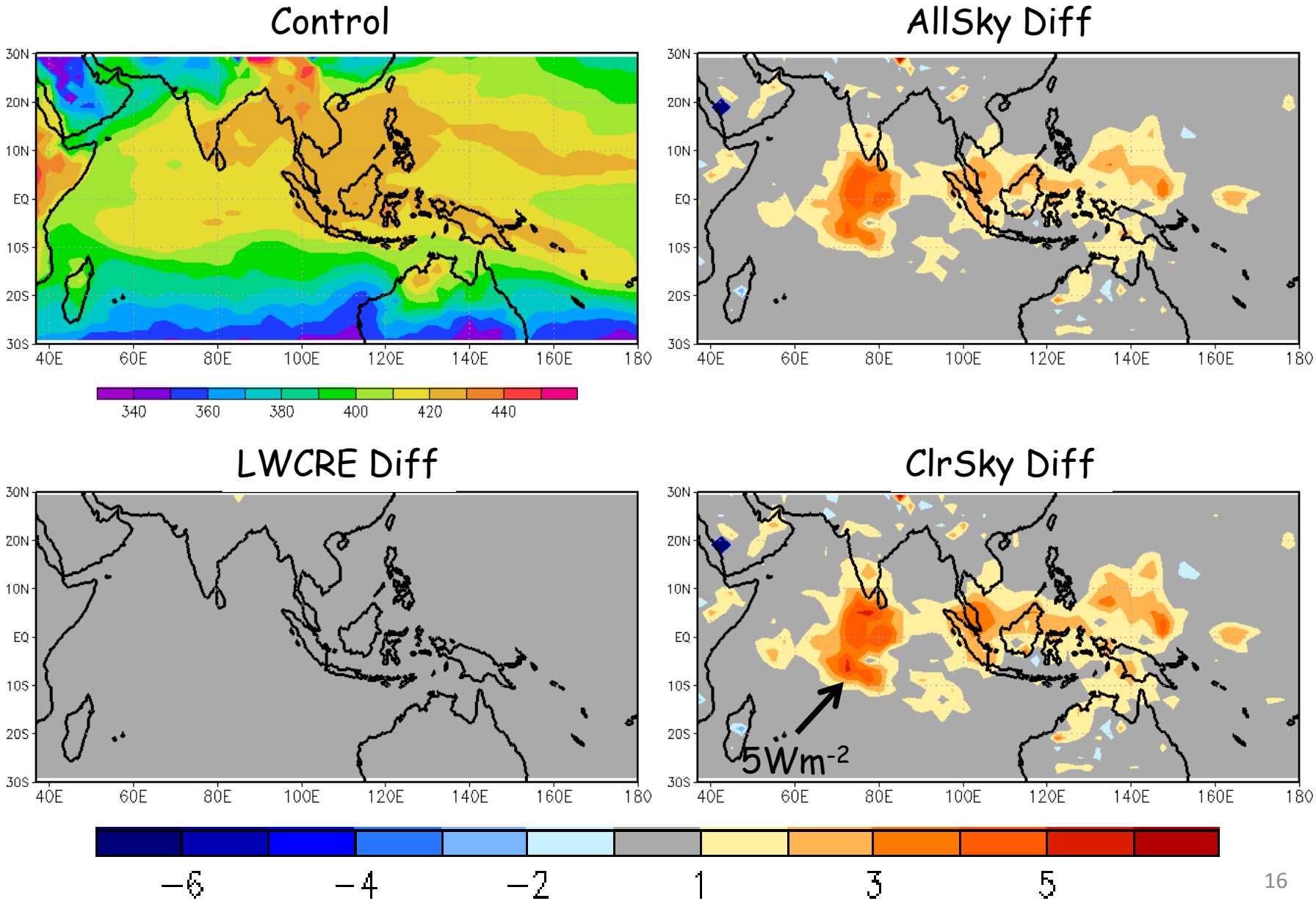
OLR: ΔT vs ΔQ



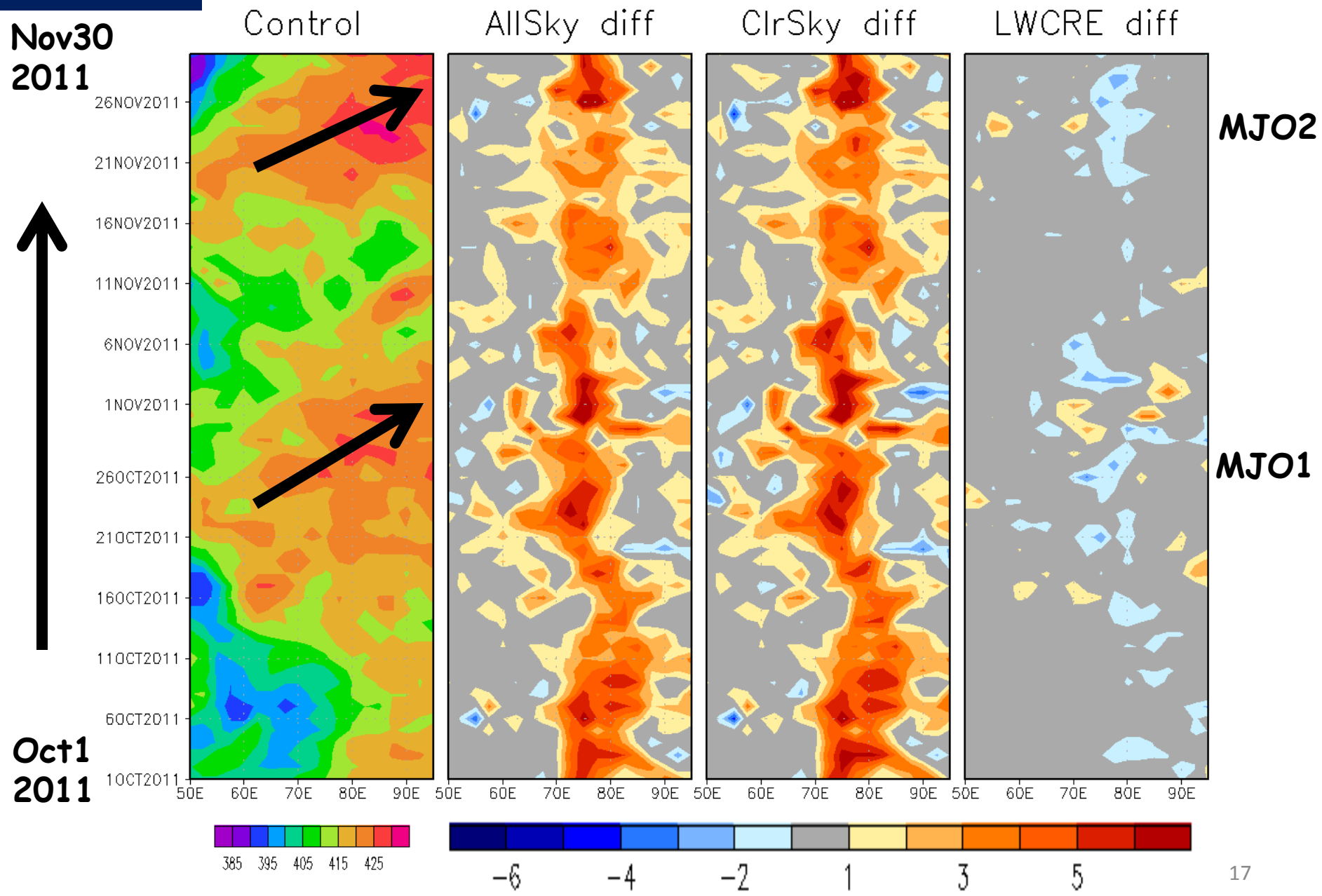
ΔQ: dominant

Surface downward LW: Oct2011

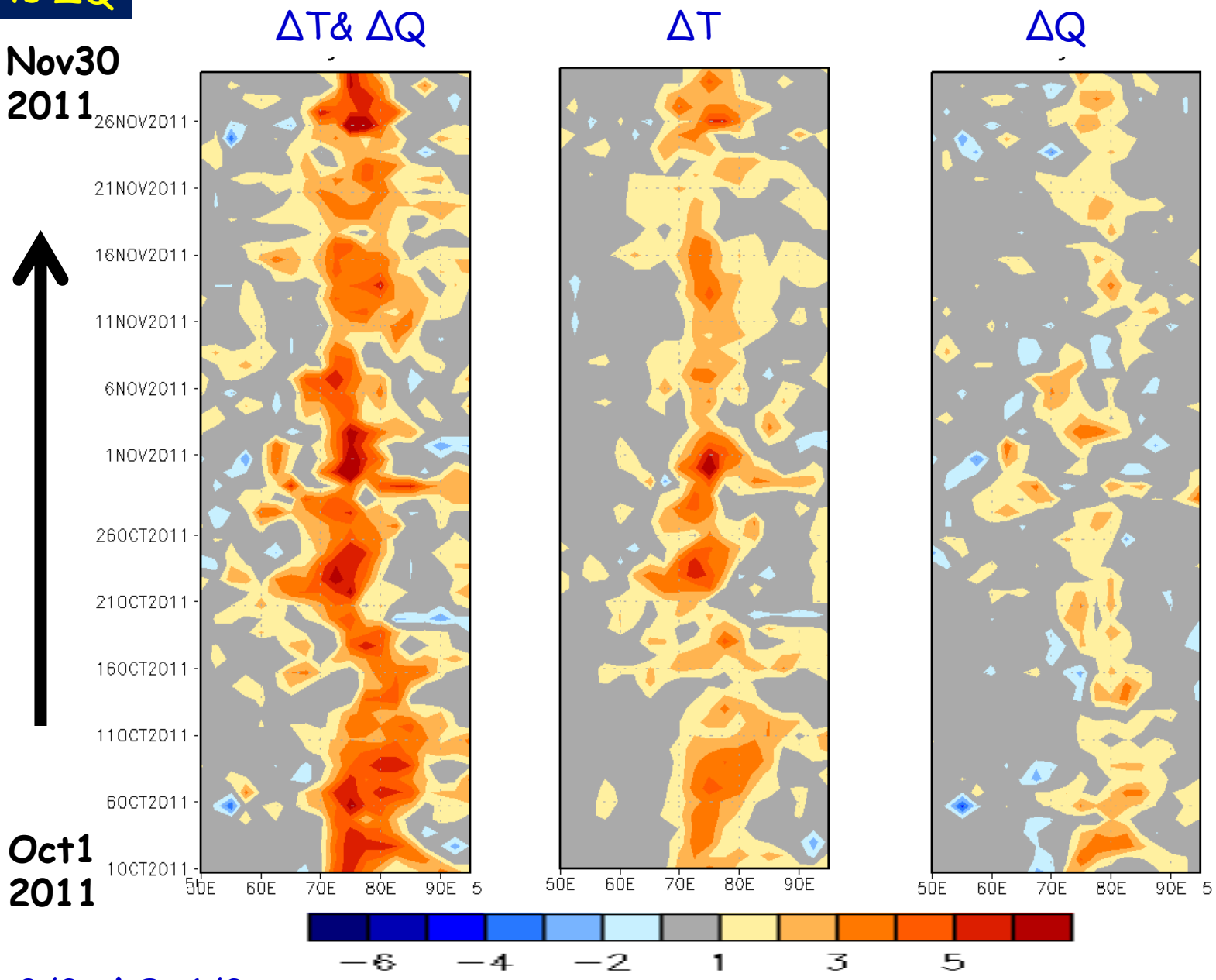
FuLiou_DYNAMO vs. FuLiou_Control



Surface downward LW
0-10N mean



Surface downward LW
ΔT vs ΔQ



ΔT: 2/3; ΔQ: 1/3

Conclusions

- The assimilation of DYNAMO observations improves vertical profiles of T and Q in GMAO reanalysis over tropical Indian Ocean
  - partially compensating GEOS-5 AGCM moist physics deficiencies (dry/cold lower troposphere; wet/warm middle troposphere)

- The role of DYNAMO observations in affecting CERES-like surface atmosphere radiation over tropical Indian Ocean:
  - Surface downward LW: increases by 5Wm-2 regionally; primarily from ΔT, and secondarily from ΔQ
  - OLR: increases by 2-3Wm-2 regionally during dry periods; from change in ΔQ.
  - Atmospheric LW: cooling enhances